

Amendments to the Claims:

The following listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A voltage conversion apparatus converting a direct current voltage from a DC power supply into an output voltage such that ~~said the~~ output voltage is equal to a designated voltage, comprising:

a voltage converter altering a voltage level of ~~said the~~ direct current voltage to provide ~~an the~~ output voltage,

a detection unit detecting the output voltage output from ~~said the~~ voltage converter, and

a control unit controlling ~~said the~~ voltage converter based on ~~said the~~ detected output voltage and ~~said the~~ designated voltage, wherein a transient response property of ~~said the~~ voltage converter with respect to ~~said the~~ designated voltage in feedback control is consistent with a reference transient response property of the voltage converter when the voltage level of the direct current voltage is equal to a reference voltage at a first time, where the output voltage crosses the designated voltage after a first time period after the first time independent of the output voltage at the first time, ~~and said output voltage is equal to said designated voltage.~~

2. (Previously Presented) The voltage conversion apparatus according to claim 1, wherein

said voltage converter includes a chopper circuit,

said control unit comprises

a feedback voltage control value calculation unit detecting a difference between said output voltage and said designated voltage to determine a control gain in said feedback control in accordance with the detected difference, and calculating a feedback voltage control value in said feedback control such that said transient response property is equal to said reference transient response property based on the determined control gain, said output voltage, and said difference,

a duty ratio calculation unit calculating a switching duty ratio of said chopper circuit, based on said calculated feedback voltage control value, and

a switching signal generation unit generating a switching signal having said switching duty ratio, and providing the generated switching signal to said chopper circuit.

3. (Previously Presented) The voltage conversion apparatus according to claim 2, wherein said feedback voltage control value calculation unit calculates said feedback voltage control value by correcting a feedback preliminary voltage control value calculated using said control gain such that said transient response property is equal to said reference transient response property.

4. (Previously Presented) The voltage conversion apparatus according to claim 3, wherein said feedback voltage control value calculation unit comprises

a subtracter calculating a difference between said output voltage and said designated voltage,

a gain determination unit determining said control gain based on said difference,

a computing element calculating said feedback preliminary voltage control value based on said determined control gain, and

a corrector correcting said feedback preliminary voltage control value by converting said output voltage into a reference voltage where said transient response property is equal to said reference transient response property to output said feedback voltage control value.

5. (Currently Amended) ~~The voltage conversion apparatus according to claim 4, wherein said corrector calculates a ratio of said reference voltage to said output voltage, and multiplies the calculated result by said feedback preliminary voltage control value to correct said feedback preliminary voltage control value.~~ A voltage conversion apparatus converting a direct current voltage from a DC power supply into an output voltage such that the output voltage is equal to a designated voltage, comprising:

a voltage converter altering a voltage level of the direct current voltage to provide the output voltage, wherein the voltage converter includes a chopper circuit;

a detection unit detecting the output voltage output from the voltage converter; and

a control unit controlling the voltage converter based on the detected output voltage and the designated voltage, where the control unit includes a feedback voltage control value calculation unit, a duty ratio calculation unit, and a switching signal generation unit,

wherein

a transient response property of the voltage converter with respect to the designated voltage in feedback control is equal to a reference transient response property of the voltage converter;

the feedback voltage control value calculation unit calculates a feedback voltage control value, the feedback voltage control value calculation unit including

a subtracter calculating a difference between the output voltage and the designated voltage;

a gain determination unit determining, based on the difference between the output voltage and the designated voltage, a control gain in the feedback control;

a computing element calculating a feedback preliminary voltage control value based on the determined control gain; and

a corrector calculating a ratio of a reference voltage to the output voltage, and calculating the feedback voltage control value by multiplying the feedback preliminary voltage control value by the calculated ratio;

the duty ratio calculation unit calculates, based on the calculated feedback voltage control value, a switching duty ratio of the chopper circuit; and

the switching signal generation unit generates a switching signal having the switching duty ratio, and provides the generated switching signal to the chopper circuit.

6. (Previously Presented) The voltage conversion apparatus according to claim 2, wherein said feedback voltage control value calculation unit calculates said feedback voltage control value by correcting said difference such that said transient response property is equal to said reference transient response property.

7. (Previously Presented) The voltage conversion apparatus according to claim 6, wherein said feedback voltage control value calculation unit comprises

a subtracter calculating a difference between said output voltage and said designated voltage,

a corrector correcting said difference such that said transient response property is equal to said reference transient response property,

a gain determination unit determining said control gain based on said difference, and

a computing element calculating said feedback voltage control value based on said determined control gain and said corrected difference.

8. (Previously Presented) The voltage conversion apparatus according to claim 7, wherein said corrector corrects said difference by converting said output voltage into a reference voltage where said transient response property is equal to said reference transient response property.

9. (Currently Amended) ~~The voltage conversion apparatus according to claim 8, wherein said corrector calculates a ratio of said reference voltage to said output voltage, and corrects said difference by multiplying the calculated result by said difference.~~ A voltage conversion apparatus converting a direct current voltage from a DC power supply into an output voltage such that the output voltage is equal to a designated voltage, comprising:

a voltage converter altering a voltage level of the direct current voltage to provide the output voltage, wherein the voltage converter includes a chopper circuit;

a detection unit detecting the output voltage output from the voltage converter; and

a control unit controlling the voltage converter based on the detected output voltage and the designated voltage, where the control unit includes a feedback voltage control value calculation unit, a duty ratio calculation unit, and a switching signal generation unit,

wherein

a transient response property of the voltage converter with respect to the designated voltage in feedback control is equal to a reference transient response property of the voltage converter;

the feedback voltage control value calculation unit calculates a feedback voltage control value, the feedback voltage control value calculation unit including

a subtracter calculating a difference between the output voltage and the designated voltage;

a corrector calculating a ratio of a reference voltage to the output voltage and correcting the difference by multiplying the difference by the calculated ratio;

a gain determination unit determining a control gain in the feedback control based on the difference; and

a computing element calculating the feedback voltage control value based on the determined control gain and the corrected difference;

the duty ratio calculation unit calculates, based on the calculated feedback voltage control value, a switching duty ratio of the chopper circuit; and

the switching signal generation unit generates a switching signal having the switching duty ratio, and provides the generated switching signal to the chopper circuit.

10. (Previously Presented) The voltage conversion apparatus according to claim 1, wherein

said voltage converter includes of a chopper circuit,

said control unit comprises

a feedback voltage control value calculation unit detecting a difference between said output voltage and said designated voltage to determine a control gain in said feedback control in accordance with the detected difference, and calculating a feedback preliminary voltage control value in said feedback control based on the determined control gain, said output voltage, and said difference,

a duty ratio calculation unit calculating a switching duty ratio of said chopper circuit such that said transient response property is equal to said reference transient response property, based on said calculated feedback preliminary voltage control value and said output voltage, and

a switching signal generation unit generating a switching signal having said switching duty ratio, and providing the generated switching signal to said chopper circuit.

11. (Currently Amended) ~~The voltage conversion apparatus according to claim 10, wherein said duty ratio calculation unit calculates said switching duty ratio by correcting a preliminary duty ratio calculated using said feedback preliminary voltage control value such that said transient response property is equal to said reference transient response property.~~ A voltage conversion apparatus converting a direct current voltage from a DC power supply into an output voltage such that the output voltage is equal to a designated voltage, comprising:

a voltage converter altering a voltage level of the direct current voltage to provide the output voltage, wherein the voltage converter includes a chopper circuit;

a detection unit detecting the output voltage output from the voltage converter; and

a control unit controlling the voltage converter based on the detected output voltage and the designated voltage, where the control unit includes a feedback voltage control value calculation unit, a duty ratio calculation unit, and a switching signal generation unit,

wherein

a transient response property of the voltage converter with respect to the designated voltage in feedback control is equal to a reference transient response property, and the output voltage is equal to the designated voltage;

the feedback voltage control value calculation unit detects a difference between the output voltage and the designated voltage to determine a control gain in the feedback control in accordance with the detected difference, and calculates a feedback preliminary voltage control value in the feedback control based on the determined control gain, the output voltage, and the difference;

the duty ratio calculation unit calculates, based on the calculated feedback preliminary voltage control value and the output voltage, a switching duty ratio of the chopper circuit by correcting a preliminary duty ratio calculated using the feedback preliminary voltage control value; and

the switching signal generation unit generates a switching signal having the switching duty ratio, and provides the generated switching signal to the chopper circuit.

12. (Previously Presented) The voltage conversion apparatus according to claim 11, wherein said duty ratio calculation unit comprises

a computing element calculating said preliminary duty ratio in accordance with said feedback preliminary voltage control value, and

a corrector correcting said preliminary duty ratio such that said transient response property is equal to said reference transient response property.

13. (Previously Presented) The voltage conversion apparatus according to claim 12, wherein said corrector corrects said preliminary duty ratio by converting said output voltage into a reference voltage where said transient response property is equal to said reference transient response property.

14. (Previously Presented) The voltage conversion apparatus according to claim 13, wherein said corrector calculates a ratio of said reference voltage to said output voltage, and corrects said preliminary duty ratio by multiplying the calculated result by said preliminary duty ratio.

15. (Currently Amended) A voltage conversion method of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that ~~said the~~ output voltage is equal to a designated voltage, ~~said the~~ method comprising:

a first step of detecting ~~said the~~ output voltage,

a second step of detecting a difference between ~~said the~~ designated voltage and ~~said the~~ output voltage,

a third step of determining a control gain in accordance with ~~said the~~ detected difference, and

a fourth step of converting ~~said the~~ direct current voltage, based on ~~said the~~ determined control gain, ~~said the~~ detected difference, and ~~said the~~ detected output voltage, into ~~said the~~ output voltage, wherein a transient response property of ~~said the~~ output voltage with respect to ~~said the~~ designated voltage in ~~said the~~ feedback control is consistent with a reference transient response property of the output voltage when the voltage level of the direct current voltage is equal to a reference voltage at a first time, where the output voltage crosses the designated voltage after a first time period after the first time independent of the output voltage at the first time., and said output voltage is equal to said designated voltage.

16. (Previously Presented) The voltage conversion method according to claim 15, wherein

said direct current voltage being converted into said output voltage by a chopper circuit,

said fourth step comprises

a first substep of calculating a feedback voltage control value that causes said transient response property to match said reference transient response property in said feedback control, based on said control gain, said difference, and said output voltage,

a second substep of calculating a switching duty ratio of said chopper circuit using said feedback voltage control value, and

a third substep of controlling said chopper circuit such that said output voltage is equal to said designated voltage, based on said switching duty ratio.

17. (Original) The voltage conversion method according to claim 16, wherein said first substep includes

the step of calculating a feedback preliminary voltage control value in said feedback control based on said control gain and said difference, and

the step of calculating said feedback voltage control value by correcting said feedback preliminary voltage control value using said output voltage.

18. (Currently Amended) ~~The voltage conversion method according to claim 17, wherein said step of calculating said feedback voltage control value includes~~
~~—— the step of calculating a conversion ratio required to convert said output voltage into a reference voltage where said transient response property is equal to said reference transient response property, and~~
~~—— the step of multiplying said feedback preliminary voltage control value by said conversion ratio to calculate said feedback voltage control value.~~ A voltage conversion method of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that the output voltage is equal to a designated voltage, the method comprising:

detecting the output voltage;
detecting a difference between the designated voltage and the output voltage;
determining a control gain in accordance with the detected difference; and
converting, using a chopper circuit, the direct current voltage into the output voltage based on the determined control gain, the detected difference, and the detected output voltage, wherein a transient response property of the output voltage with respect to the designated voltage in the feedback control is equal to a reference transient response property, and wherein the step of converting further includes

a first substep of calculating a feedback preliminary voltage control value in the feedback control based on the determined control gain and the difference;

a second substep of calculating a conversion ratio required to convert the output voltage into a reference voltage, and multiplying the feedback preliminary voltage control value by the conversion ratio to calculate the feedback voltage control value that causes the transient response property to match the reference transient response property in the feedback control;

a third substep of calculating, based on the calculated feedback voltage control value, a switching duty ratio of the chopper circuit; and

a fourth substep of controlling the chopper circuit based on the switching duty ratio, wherein the output voltage outputted by the chopper is equal to the designated voltage.

19. (Previously Presented) The voltage conversion method according to claim 16, wherein said first substep includes

the step of calculating a correction difference where said transient response property is equal to said reference transient response property by correcting said difference using said output voltage, and

the step of calculating said feedback voltage control value based on said control gain and said correction difference.

20. (Currently Amended) ~~The voltage conversion method according to claim 19, wherein said step of calculating said correction difference includes~~

~~—— the step of calculating a conversion ratio required to convert said output voltage into a reference voltage where said transient response property is equal to said reference transient response property, and~~

~~—— the step of multiplying said difference by said conversion ratio to calculate said correction difference.~~ A voltage conversion method of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that the output voltage is equal to a designated voltage, the method comprising:

detecting the output voltage;

detecting a difference between the designated voltage and the output voltage;

determining a control gain in accordance with the detected difference; and

converting, using a chopper circuit, the direct current voltage into the output voltage based on the determined control gain, the detected difference, and the detected output voltage, wherein a transient response property of the output voltage with respect to the designated voltage in the feedback control is equal to a reference transient response property, and wherein the step of converting further includes

a first substep of calculating a conversion ratio required to convert the output voltage into a reference voltage where the transient response property is equal to the reference transient response property;

a second substep of multiplying the detected difference by the conversion ratio to calculate a correction difference;

a third substep of calculating a feedback voltage control value based on the control gain and the correction difference;

a fourth substep of calculating, based on the calculated feedback voltage control value, a switching duty ratio of the chopper circuit; and

a fifth substep of controlling the chopper circuit based on the switching duty ratio, wherein the output voltage outputted by the chopper circuit is equal to the designated voltage.

21. (Currently Amended) ~~The voltage conversion method according to claim 15, wherein said direct current voltage being converted into said output voltage by a chopper circuit,~~

~~—— said fourth step comprises~~

~~—— a first substep of calculating a feedback preliminary voltage control value in said feedback control based on said control gain and said difference,~~

~~—— a second substep of calculating a preliminary switching duty ratio of said chopper circuit based on said feedback preliminary voltage control value,~~

~~—— a third substep of correcting said preliminary switching duty ratio using said output voltage to calculate a switching duty ratio where said transient response property is equal to said reference transient response property, and~~

~~—— a fourth substep of controlling said chopper circuit such that output voltage is equal to said designated voltage, based on said switching duty ratio.~~ A voltage conversion method of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that the output voltage is equal to a designated voltage, the method comprising:

a first step of detecting the output voltage;

a second step of detecting a difference between the designated voltage and the output voltage;

a third step of determining a control gain in accordance with the detected difference;
and

a fourth step of converting, using a chopper circuit, the direct current voltage into the output voltage based on the determined control gain, the detected difference, and the detected

output voltage, wherein a transient response property of the output voltage with respect to the designated voltage in the feedback control is equal to a reference transient response property, and wherein

the fourth step further includes

a first substep of calculating a feedback preliminary voltage control value in the feedback control based on the determined control gain and the detected difference;

a second substep of calculating a preliminary switching duty ratio of the chopper circuit based on the feedback preliminary voltage control value;

a third substep of correcting the preliminary switching duty ratio using the output voltage to calculate a switching duty ratio where the transient response property is equal to the reference transient response property; and

a fourth substep of controlling the chopper circuit based on the switching duty ratio, wherein the output voltage outputted by the chopper circuit is equal to the designated voltage.

22. (Previously Presented) The voltage conversion method according to claim 21, wherein said third substep includes

the step of calculating a conversion ratio required to convert said output voltage into a reference voltage where said transient response property is equal to said reference transient response property, and

the step of multiplying said preliminary switching duty ratio by said conversion ratio to calculate said switching duty ratio.

23. (Currently Amended) A computer-readable recording medium with a program recorded thereon to allow a computer to execute control of voltage conversion of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that ~~said the~~ output voltage is equal to a designated voltage, ~~said the~~ computer executing:

a first step of detecting ~~said the~~ output voltage,

a second step of detecting a difference between ~~said the~~ designated voltage and ~~said the~~ output voltage,

a third step of determining a control gain in accordance with ~~said the~~ detected difference, and

a fourth step of converting ~~said-the~~ direct current voltage, based on ~~said-the~~ determined control gain, ~~said-the~~ detected difference, and ~~said-the~~ detected output voltage, into ~~said-output-voltage~~, the output voltage, wherein a transient response property of ~~said-the~~ output voltage with respect to ~~said-the~~ designated voltage in ~~said-the~~ feedback control is consistent with a reference transient response property of the output voltage when the voltage level of the direct current voltage is equal to a reference voltage at a first time, where the output voltage crosses the designated voltage after a first time period after the first time independent of the output voltage at the first time., ~~and said-output-voltage is equal to said designated voltage.~~

24. (Previously Presented) The computer-readable recording medium recorded with a program thereon to be executed by a computer according to claim 23, wherein said direct current voltage being converted into said output voltage by a chopper circuit,

said fourth step comprises

a first substep of calculating a feedback voltage control value that causes said transient response property to match said reference transient response property in said feedback control, based on said control gain, said difference, and said output voltage,

a second substep of calculating a switching duty ratio of said chopper circuit using said feedback voltage control value, and

a third substep of controlling said chopper circuit such that said output voltage is equal to said designated voltage, based on said switching duty ratio.

25. (Original) The computer-readable recording medium recorded with a program thereon to be executed by a computer according to claim 24, wherein said first substep includes

the step of calculating a feedback preliminary voltage control value in said feedback control based on said control gain and said difference, and

the step of calculating said feedback voltage control value by correcting said feedback preliminary voltage control value using said output voltage.

26. (Currently Amended) ~~The computer-readable recording medium recorded with a program thereon to be executed by a computer according to claim 25, wherein said step of calculating said feedback voltage control value includes~~
~~—— the step of calculating a conversion ratio required to convert said output voltage into a reference voltage where said transient response property is equal to said reference transient response property, and~~
~~—— the step of multiplying said feedback preliminary voltage control value by said conversion ratio to calculate said feedback voltage control value.~~ A computer-readable recording medium with a program recorded thereon to allow a computer to execute control of voltage conversion of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that the output voltage is equal to a designated voltage, the computer executing:
detecting the output voltage;
detecting a difference between the designated voltage and the output voltage;
determining a control gain in accordance with the detected difference; and
converting, using a chopper circuit, the direct current voltage into the output voltage based on the determined control gain, the detected difference, and the detected output voltage, wherein a transient response property of the output voltage with respect to the designated voltage in the feedback control is equal to a reference transient response property, and wherein the step of converting further includes
a first substep of calculating a feedback preliminary voltage control value in the feedback control based on the determined control gain and the difference;
a second substep of calculating a conversion ratio required to convert the output voltage into a reference voltage, and multiplying the feedback preliminary voltage control value by the conversion ratio to calculate the feedback voltage control value that causes the transient response property to match the reference transient response property in the feedback control;
a third substep of calculating, based on the calculated feedback voltage control value, a switching duty ratio of the chopper circuit; and
a fourth substep of controlling the chopper circuit based on the switching duty ratio, wherein the output voltage outputted by the chopper is equal to the designated voltage.

27. (Previously Presented) The computer-readable recording medium recorded with a program thereon to be executed by a computer according to claim 24, wherein said first substep includes

the step of calculating a correction difference where said transient response property is equal to said reference transient response property by correcting said difference using said output voltage, and

the step of calculating said feedback voltage control value based on said control gain and said correction difference.

28. (Currently Amended) ~~The computer-readable recording medium recorded with a program thereon to be executed by a computer according to claim 27, wherein said step of calculating said correction difference includes~~

~~—— the step of calculating a conversion ratio required to convert said output voltage into a reference voltage where said transient response property is equal to said reference transient response property, and~~

~~—— the step of multiplying said difference by said conversion ratio to calculate said correction difference.~~ A computer-readable recording medium with a program recorded thereon to allow a computer to execute control of voltage conversion of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that the output voltage is equal to a designated voltage, the computer executing:

detecting the output voltage;

detecting a difference between the designated voltage and the output voltage;

determining a control gain in accordance with the detected difference; and

converting, using a chopper circuit, the direct current voltage into the output voltage based on the determined control gain, the detected difference, and the detected output voltage, wherein a transient response property of the output voltage with respect to the designated voltage in the feedback control is equal to a reference transient response property, and wherein the step of converting further includes

a first substep of calculating a conversion ratio required to convert the output voltage into a reference voltage where the transient response property is equal to the reference transient response property;

a second substep of multiplying the detected difference by the conversion ratio to calculate a correction difference;

a third substep of calculating a feedback voltage control value based on the control gain and the correction difference;

a fourth substep of calculating, based on the calculated feedback voltage control value, a switching duty ratio of the chopper circuit; and

a fifth substep of controlling the chopper circuit based on the switching duty ratio, wherein the output voltage outputted by the chopper circuit is equal to the designated voltage.

29. (Currently Amended) ~~The computer-readable recording medium recorded with a program thereon to be executed by a computer according to claim 23, wherein~~
~~—— said direct current voltage being converted into said output voltage by a chopper circuit;~~
~~—— said fourth step comprises~~
~~—— a first substep of calculating a feedback preliminary voltage control value in said feedback control based on said control gain and said difference;~~
~~—— a second substep of calculating a preliminary switching duty ratio of said chopper circuit based on said feedback preliminary voltage control value;~~
~~—— a third substep of correcting said preliminary switching duty ratio using said output voltage to calculate a switching duty ratio where said transient response property is equal to said reference transient response property; and~~
~~—— a fourth substep of controlling said chopper circuit such that output voltage is equal to said designated voltage, based on said switching duty ratio.~~
A computer-readable recording medium with a program recorded thereon to allow a computer to execute control of voltage conversion of converting a direct current voltage from a DC power supply into an output voltage under feedback control such that the output voltage is equal to a designated voltage, the computer executing:

a first step of detecting the output voltage;

a second step of detecting a difference between the designated voltage and the output voltage;

a third step of determining a control gain in accordance with the detected difference;
and

a fourth step of converting, using a chopper circuit, the direct current voltage into the output voltage based on the determined control gain, the detected difference, and the detected

output voltage, wherein a transient response property of the output voltage with respect to the designated voltage in the feedback control is equal to a reference transient response property, and wherein

the fourth step further includes

a first substep of calculating a feedback preliminary voltage control value in the feedback control based on the determined control gain and the detected difference;

a second substep of calculating a preliminary switching duty ratio of the chopper circuit based on the feedback preliminary voltage control value;

a third substep of correcting the preliminary switching duty ratio using the output voltage to calculate a switching duty ratio where the transient response property is equal to the reference transient response property; and

a fourth substep of controlling the chopper circuit based on the switching duty ratio, wherein the output voltage outputted by the chopper circuit is equal to the designated voltage.

30. (Previously Presented) The computer-readable recording medium recorded with a program thereon to be executed by a computer according to claim 29, wherein said third substep includes

the step of calculating a conversion ratio required to convert said output voltage into a reference voltage where said transient response property is equal to said reference transient response property, and

the step of multiplying said preliminary switching duty ratio by said conversion ratio to calculate said switching duty ratio.